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FLEXIBLE VESSEL

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation-in-part of U.S. Application Serial Number 10/351,966, filed January 27, 2003, titled "FLEXIBLE VESSEL", the contents of which are incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to sea transportation vessels and methodologies generally and more particularly to vessels and methodologies for transport of liquids.

BACKGROUND OF THE INVENTION

[0003] The following published Patent Documents are believed to represent the current state of the art:

[0004] Applicant's Published PCT Application WO 01/92097 A1;

[0005] U.S. Patents: 6,047,655; 5,971,039; 5,488,921; 5,445,093; 5,413,065; 5,355,819; 5,235,928; 5,010,837; 4,881,482; 4,399,768; 4,227,477; 4,178,868; 3,779,196; 3,750,723; 3,067,712.

SUMMARY OF THE INVENTION

[0006] The present invention seeks to provide highly efficient and cost effective vessels and methodologies for sea transport of liquids.

[0007] There is thus provided in accordance with a preferred embodiment of the present invention an apparatus for sea transport of fresh water including at least one fresh water enclosure communicating with at least one fresh water loading/unloading valve, a plurality of at least partially flexible, collapsible sea water enclosures disposed within each of the at least one fresh water enclosure and at least one opening communicating with each one of the plurality of sea water enclosures for selectably allowing sea water to fill the plurality of sea water enclosures, thereby causing the fresh water to be expelled against the force of gravity from the at least one fresh water enclosure.

[0008] Preferably, the at least one fresh water enclosure is a flexible enclosure.

[0009] In accordance with a preferred embodiment of the present invention the apparatus also includes a plurality of mutually spaced enclosure cross-section defining assemblies. Additionally, the sea water enclosures are disposed intermediate adjacent pairs of the enclosure cross-section defining assemblies.

[0010] There is also provided in accordance with another preferred embodiment of the present invention an apparatus for sea transport of fresh water including a flexible enclosure including a plurality of mutually spaced enclosure cross-section defining assemblies and a plurality of at least partially flexible, collapsible sea water enclosures disposed within the flexible enclosure, wherein the sea water enclosures are disposed intermediate adjacent pairs of the enclosure cross-section defining assemblies. Additionally, the flexible enclosure includes at least one fresh water enclosure communicating with at least one fresh water loading/unloading valve. Preferably, the apparatus also includes a plurality of openings communicating with the plurality of sea water enclosures for selectably allowing sea water to fill the plurality of sea water enclosures, thereby causing the fresh water to be expelled against the force of gravity from the at least one fresh water enclosure.

[0011] Preferably, the enclosure cross-section defining assembly includes an elongate float element. Additionally, the elongate float element is attached to an interior top surface of the fresh water enclosure. Additionally, the elongate float element is

attached to an interior top surface of the fresh water enclosure by a plurality of mutually spaced straps.

[0012] Preferably, the elongate float element floats on sea water.

[0013] In accordance with another preferred embodiment of the present invention, the enclosure cross-section defining assembly also includes a multiplicity of weighting elements attached to a bottom portion. Preferably, the multiplicity of weighting elements each include a water resistant container filled with metal.

[0014] In accordance with yet another preferred embodiment of the present invention the enclosure cross-section defining assembly also includes a first plurality of straps attached to the elongate float element at a plurality of locations, a second plurality of vertically extending straps, a third plurality of straps attached to the bottom element, a first plurality of rings, attaching each of the first plurality of straps to a corresponding one of the second plurality of straps and a second plurality of rings, attaching each of the second plurality of straps to a corresponding one of the third plurality of straps.

[0015] In accordance with still another preferred embodiment of the present invention the enclosure cross-section defining assembly also includes a first and a second generally vertically extending side supports, attached to interior side surfaces of the fresh water enclosure, a fourth plurality of side-to-side extending straps, attached to the first generally vertically extending side support, a fifth plurality of side-to-side extending straps, attached to the second generally vertically extending side support, a sixth plurality of horizontally extending straps, a third plurality of rings, connecting each of the fourth plurality of straps to a corresponding one of the sixth plurality of straps and a fourth plurality of rings, connecting each of the fifth plurality of straps to a corresponding one of the sixth plurality of straps.

[0016] Additionally, in accordance with a further preferred embodiment, the second plurality of vertically extending straps and the sixth plurality of horizontally extending straps are joined at at least one junction point therebetween.

[0017] Preferably, the sea water enclosures are operative to hold sea water separately from the fresh water enclosure.

[0018] There is further provided in accordance with still another preferred embodiment of the present invention an apparatus for sea transport of light liquid including at least one light liquid enclosure communicating with at least one light liquid

loading/unloading valve, a plurality of at least partially flexible, collapsible sea water enclosures disposed within each of the at least one light liquid enclosure and at least one opening communicating with each one of the plurality of sea water enclosures for selectably allowing sea water to fill the plurality of sea water enclosures, thereby causing the light liquid to be expelled against the force of gravity from the at least one light liquid enclosure, wherein the light liquid is lighter than sea water.

[0019] Preferably, the at least one light liquid enclosure is a flexible enclosure.

[0020] In accordance with yet another preferred embodiment of the present invention the apparatus also includes a plurality of mutually spaced enclosure cross-section defining assemblies. Additionally, the sea water enclosures are disposed intermediate adjacent pairs of the enclosure cross-section defining assemblies.

[0021] There is still further provided in accordance with another preferred embodiment of the present invention an apparatus for sea transport of light liquid including a flexible enclosure including a plurality of mutually spaced enclosure cross-section defining assemblies and a plurality of at least partially flexible, collapsible sea water enclosures disposed within the flexible enclosure, wherein the sea water enclosures are disposed intermediate adjacent pairs of the enclosure cross-section defining assemblies. Additionally, the flexible enclosure includes at least one light liquid enclosure communicating with at least one light liquid loading/unloading valve. Preferably, the apparatus also includes a plurality of openings communicating with the plurality of sea water enclosures for selectably allowing sea water to fill the plurality of sea water enclosures, thereby causing the light liquid to be expelled against the force of gravity from the at least one light liquid enclosure.

[0022] Preferably, the enclosure cross-section defining assembly includes an elongate float element. Additionally, the enclosure cross-section defining assembly also includes a multiplicity of weighting elements attached to a bottom portion. Further in accordance with another preferred embodiment of the present invention, the enclosure cross-section defining assembly also includes a first plurality of straps attached to the elongate float element at a plurality of locations, a second plurality of vertically extending straps, a third plurality of straps attached to the bottom element, a first plurality of rings, attaching each of the first plurality of straps to a corresponding one of the second plurality of straps, a second plurality of rings, attaching each of the second

plurality of straps to a corresponding one of the third plurality of straps, a first and a second generally vertically extending side supports, attached to interior side surfaces of the light liquid enclosure, a fourth plurality of side-to-side extending straps, attached to the first generally vertically extending side support, a fifth plurality of side-to-side extending straps, attached to the second generally vertically extending side support, a sixth plurality of horizontally extending straps, a third plurality of rings, connecting each of the fourth plurality of straps to a corresponding one of the sixth plurality of straps and a fourth plurality of rings, connecting each of the fifth plurality of straps to a corresponding one of the sixth plurality of straps.

[0023] Preferably, the sea water enclosures are operative to hold sea water separately from the light liquid enclosure.

[0024] There is also provided in accordance with a preferred embodiment of the present invention a method for sea transport of fresh water including providing a vessel including at least one fresh water enclosure communicating with at least one fresh water loading/unloading valve, a plurality of at least partially flexible, collapsible sea water enclosures disposed within each of the at least one fresh water enclosure and at least one opening communicating with each one of the plurality of sea water enclosures, loading the vessel by selectably filling the fresh water enclosure with fresh water and unloading the vessel by selectably allowing sea water to fill the plurality of sea water enclosures, thereby causing the fresh water to be expelled against the force of gravity from the at least one fresh water enclosure.

[0025] There is further provided in accordance with another preferred embodiment of the present invention a method for sea transport of fresh water including providing a vessel including a flexible enclosure including a plurality of mutually spaced enclosure cross-section defining assemblies and a plurality of at least partially flexible, collapsible sea water enclosures disposed within the flexible enclosure, wherein the sea water enclosures are disposed intermediate adjacent pairs of the enclosure cross-section defining assemblies, loading the vessel by selectably filling the flexible enclosure with fresh water and unloading the vessel by selectably allowing sea water to fill the plurality of sea water enclosures, thereby causing the fresh water to be expelled against the force of gravity from the flexible enclosure.

[0026] There is still further provided in accordance with yet another preferred

embodiment of the present invention a method for sea transport of light liquid including providing a vessel including at least one light liquid enclosure communicating with at least one light liquid loading/unloading valve, a plurality of at least partially flexible, collapsible sea water enclosures disposed within each of the at least one light liquid enclosure and at least one opening communicating with each one of the plurality of sea water enclosures, loading the vessel by selectably filling the light liquid enclosure with light liquid and unloading the vessel by selectably allowing sea water to fill the plurality of sea water enclosures, thereby causing the light liquid to be expelled against the force of gravity from the at least one light liquid enclosure.

[0027] There is even further provided in accordance with still another preferred embodiment of the present invention a method for sea transport of light liquid including providing a vessel including a flexible enclosure including a plurality of mutually spaced enclosure cross-section defining assemblies and a plurality of at least partially flexible, collapsible sea water enclosures disposed within the flexible enclosure, wherein the sea water enclosures are disposed intermediate adjacent pairs of the enclosure cross-section defining assemblies, loading the vessel by selectably filling the flexible enclosure with light liquid and unloading the vessel by selectably allowing sea water to fill the plurality of sea water enclosures, thereby causing the light liquid to be expelled against the force of gravity from the flexible enclosure.

[0028] Preferably, the loading takes place principally by gravity and the unloading take place principally without requiring pumping.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawings in which:

[0030] Fig. 1 is a simplified pictorial illustration of apparatus for sea transport of liquids constructed and operative in accordance with a preferred embodiment of the present invention;

[0031] Fig. 2A is a simplified sectional illustration of the apparatus of Fig. 1, taken along lines IIA - IIA in Fig. 1;

[0032] Fig. 2B is a simplified sectional illustration of the apparatus of Fig. 1, taken along lines IIB - IIB in Fig. 1;

[0033] Fig. 3 is a simplified sectional illustration of the apparatus of Fig. 1, taken along the lines III - III in Fig. 1;

[0034] Figs. 4A, 4B, 4C and 4D are sectional illustrations of portions of the apparatus of Fig. 3, taken along respective lines IVA - IVA, IVB - IVB, IVC - IVC and IVD - IVD in Fig 3;

[0035] Fig. 5 is a cut away pictorial illustration of the apparatus of Figs. 3 – 4D;

[0036] Fig. 6 is a pictorial illustration of a transport network employing the vessels and methodologies of Figs. 1 – 5;

[0037] Figs. 7A, 7B, 7C and 7D are simplified illustrations of four stages in transport and unloading of fresh water from a vessel of the type illustrated in Figs. 1 - 6 in accordance with a preferred embodiment of the present invention; and

[0038] Figs. 8A, 8B and 8C are simplified illustrations of three stages in loading of fresh water onto a vessel of the type illustrated in Figs. 1 - 7D.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0039] Reference is now made to Figs. 1-5, which illustrate apparatus for sea transport of liquids, constructed and operative in accordance with a preferred embodiment of the present invention. As seen in Fig. 1, there is provided a vessel 100 for transport of liquids comprising a flexible tube-like enclosure 102 including a plurality of spaced, enclosure cross-section defining assemblies 104. Preferably the vessel has a hemispherical forward end 106 and a generally conical rearward end 108. The apparatus as shown in Figs. 2A and 2B is loaded with liquid ready for transport.

[0040] Referring additionally to Figs. 3 - 5, it is seen that the enclosure cross-section defining assemblies 104 preferably each include an elongate float element 110, which is preferably attached to an interior top surface of enclosure 102 by a plurality of mutually spaced straps 112, stitched or otherwise attached to depending supports 114, which are in turn stitched or otherwise attached to an interior top surface of enclosure 102, as seen particularly in Fig. 4A. Float elements 110 are preferably designed to float on sea water.

[0041] A plurality of straps 120 are preferably attached to elongate float element 110 at a plurality of locations, intermediate each pair of adjacent straps 112, as seen in Fig. 4B. These straps 120 are attached, as by snap rings 122, to vertically extending straps 124, which extend downwardly and are connected to corresponding rings 126 attached to a plurality of straps 127 attached to bottom element 128, to which are stitched or otherwise attached a multiplicity of weighting elements 129, as shown in Fig. 4C. Weighting elements 129 are preferably formed of water resistant material 130 and preferably filled with a metal 131 suitable for use as ballast, such as steel. The metal filling may be in any form, such as small balls or pellets or a single block. Alternatively, water resistant material 130 may be filled with any suitable material. Alternatively, weighting elements 129 may be formed of any other suitable material, such as rubber coated metal, and attached to bottom element 128. As seen in Figs. 3 and 5, more weighting elements 129 are preferably provided in proximity to the side walls of enclosure cross-section defining assemblies 104 than in the center of enclosure cross-section defining assemblies 104. The provision of weighting elements 129 provide increased flexibility to the outer surfaces of enclosure 102.

[0042] A plurality of side-to-side extending straps 132 are stitched or otherwise

attached to generally vertically extending side supports 134, which are stitched or otherwise attached to interior side surfaces of enclosure 102, as seen particularly in Fig. 4D. Straps 132 on one side of the enclosure 102 are attached, as by snap rings 136, to horizontally extending straps 138, which extend side-to-side across the interior of enclosure 102 and are connected, such as by corresponding snap rings 140, to corresponding straps 132 on the opposite side of the enclosure 102. At each junction between straps 124 and 138, the straps are preferably joined, as by stitching.

[0043] Reference is now made to Fig. 6, which is a pictorial illustration of a transport network employing the vessels of Figs. 1 – 5. It is seen that typically plural vessels 100 are located at both filling and unloading ports, designated respectively 160 and 162, so that plural vessels may be loaded and unloaded simultaneously and while other vessels travel between ports. It is seen that during both loading and unloading preferably the same fresh water loading/unloading valve 164 (Figs. 7A-8C) is employed.

[0044] Reference is now made to Figs. 7A, 7B, 7C and 7D, which are simplified illustrations of four stages in transport and unloading of fresh water from a vessel of the type illustrated in Figs. 1 - 6 in accordance with a preferred embodiment of the present invention. As seen in Figs. 7A - 7D, disposed within enclosure 102 are a plurality of flexible, collapsible, sea water enclosure elements 170, which cooperate with a bottom surface of the enclosure 102 to define sea water enclosures 172. The sea water enclosures 172 thus defined are operative to receive and hold sea water separately from fresh water lying thereabove within enclosure 102 and are each preferably open to the sea, permitting free ingress or egress of sea water thereto via an aperture 174 formed in the bottom of enclosure 102. Each one of enclosures 172 is preferably disposed intermediate each pair of adjacent cross-section defining assemblies 104. The size and number of enclosures 172 is designed so that when fully expanded, enclosures 172 are able to fill generally the entire volume of enclosure 102, as seen in Fig. 7D. As is described hereinbelow, filling of the enclosures 172 with sea water is operative to expel fresh water from enclosure 102.

[0045] Fig. 7A shows the enclosure elements 170 in a generally collapsed state. This state continues as long as fresh water is not allowed to egress the enclosure 102, inasmuch as fresh water loading/unloading valve 164 is closed. When fresh water is

allowed to egress the enclosure 102, sea water enters enclosures 172 via apertures 174 and forces the fresh water out of the enclosure 102, as shown symbolically in Fig. 7B. Fig. 7C shows further expansion of the enclosures 172 and further egress of fresh water via fresh water loading/unloading valve 164. Fig. 7D shows a situation where generally all of the fresh water from enclosure 102 has been replaced by sea water in enclosures 172. It is in this state that the vessels 100 travel from the unloading port 162 (Fig. 6) to the filling port 160 (Fig. 6).

[0046] Reference is now made to Figs. 8A - 8C, which illustrate loading of vessels 100 with fresh water. As seen in Fig. 8A, fresh water is forced into enclosure 102 via fresh water loading/unloading valve 164 by gravity or by any other suitable method. As fresh water begins to fill enclosure 102, it forces enclosures 172 to contract, forcing sea water out through apertures 174. As seen in Fig. 8B, as filling of vessel 100 with fresh water continues, enclosures 172 continue to contract and sea water continues to be forced out through apertures 174. Fig. 8C illustrates the situation where enclosure 102 is generally filed with fresh water and enclosure elements 170 lie in a generally collapsed state. It is in this state that the vessels 100 travel from the filling port 160 (Fig. 6) to the unloading port 162 (Fig. 6).

[0047] It is appreciated that even though the embodiment of Figs. 6-8C describes an apparatus for transporting fresh water, any suitable liquid lighter than sea water may also be loaded, transported and unloaded using the above apparatus and methodology.

[0048] It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described hereinabove. Rather the scope of the present invention includes both combinations and subcombinations of the various features described hereinabove as well as variations and modifications which would occur to persons skilled in the art upon reading the specification and which are not in the prior art.